the Ruby district some contract work was done for $1.50 per foot in frozen muck and $2.50 in frozen gravel of any depth.

### GASOLINE DRILLS

A very light 4-horsepower gasoline drill using 4-inch casing is popular in the Seward Peninsula for preliminary tests of unfrozen light shallow gravels, up to 15 feet deep, underlaid by soft bedrock. Such a drill has also proved successful in testing ahead of dredges. Although it can be used as a churn drill, more often the pipe is driven to bedrock without pumping. The pipe is then pulled and the core removed. Such a procedure usually returns a low percentage of core, so that the results of such drilling should not be relied on too strongly. The entire outfit weighs but 1,000 pounds;

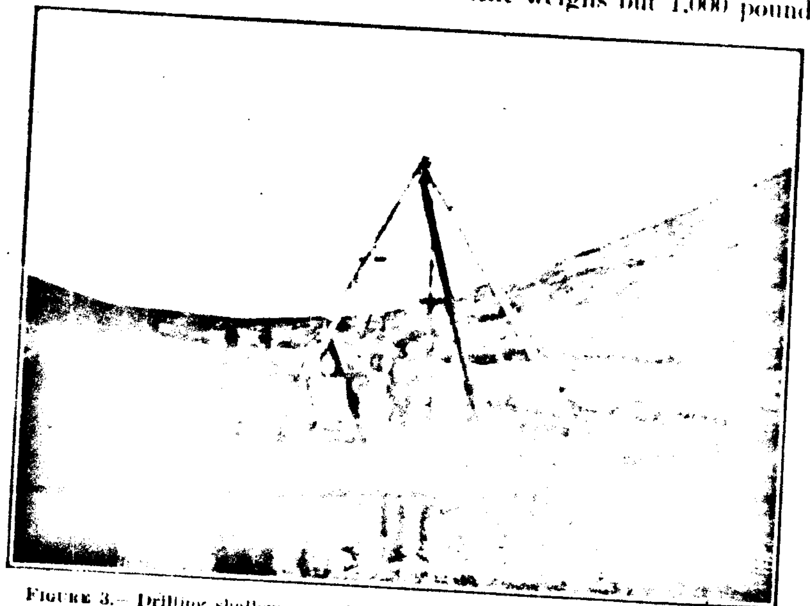

FIGURE 3.—Drilling shallow ground with 4-inch drill driven by gasoline engine

as it is mounted on two wheels, which are detached when the drill is in use, it can be easily moved (fig. 3). Three men, including the panner, constitute the crew. From 60 to 75 feet of drill hole can be made per 10-hour shift.

## WATER SUPPLY

In placer mining the water supply is of utmost importance, as it must be ample for the required output and be available at the property under conditions best suited to the system of mining used. Water supply is governed by different factors; aside from economic factors, the most important are precipitation, temperature, topography, vegetation, and evaporation. Although all forms of placer



mining require water, to obtain water for small mines that do not use water under pressure is generally not especially difficult. The problem of a water supply for use under pressure is therefore discussed in more detail here.

On the south and west slopes of the Alaska Range conditions are most favorable for comparatively large, steady supplies of water. Most of the drainage basins are above the general level of the mines, so that water for mining may be made available by comparatively short ditches or pipe lines. Annual precipitation is heavy, and seasonal temperature variations are seldom extreme. In the Nizina, Chistochina, Girdwood (fig. 1, *47*, *44*, and *49*, respectively), and other districts many streams are fed by glaciers or snowcaps and maintain a constant or increased flow during the dry summer months, when most Alaska water supplies are low.

The Yukon-Tanana or interior regions are dissected uplands, and the predominating features are series of long branching ridges of uniform elevation. Natural storage basins are generally lacking, the drainage basins or catchment areas above the diversion point of the stream are small, and the streams have uniformly low gradients. As a rule, the precipitation is considerably less than in other parts of Alaska and the summer temperatures are higher. Rapid melting of the snow, frozen ground, and sparse timber cause a rapid run-off and a widely fluctuating stream flow that depends almost directly on the precipitation. Conditions in the interior districts, therefore, are not generally favorable for obtaining satisfactory water supplies.

Most of the Seward Peninsula is rugged and much dissected by streams. The precipitation is greater and the temperature lower than in the interior of Alaska. The mountains in the central part of the peninsula receive the heaviest precipitation, and many peaks are covered with perennial snow. Catchment areas are generally large and are situated at elevations well above the point of diversion; there are some good natural storage basins. Most of the important placers, however, are far from the diversion point; hence long expensive ditches and pipe lines are necessary.[18]

## METHODS OF MEASURING FLOW OF WATER

### MINER'S INCH

The unit of water measurement ordinarily used for all classes of work is the "second-foot," and from it the quantity expressed in other terms may be obtained. It is the unit for the rate of flow

[18] For further information on water resources consult the topographic maps and water-supply papers of the U. S. Geological Survey and the climatological data issued by the U. S. Weather Bureau at Juneau.

of water moving in a stream 1 foot wide and 1 foot deep at the rate of 1 foot a second. This unit, however, is seldom used by Alaska placer miners, who are more familiar with the "miner's inch" and the "sluice head."

The "miner's inch" expresses the rate of flow and is applied to the volume of water flowing through an orifice of a given size with a given head. The head of the water and the size of the orifice differ in different States, where they are defined by the law. The California miner's inch is now the one in most common use and was defined by an act approved March 23, 1901, as follows: "The standard miner's inch of water shall be equivalent or equal to 1.5 cubic feet of water per minute, measured through any aperture or orifice." This miner's inch corresponds to the so-called "6-inch head" and is equivalent to one-fortieth of a second-foot.

Experiments made in California by A. J. Bowie, jr.,[19] to determine the volume of the miner's inch—defined as $\frac{1}{200}$ part of the quantity of water which would flow through an opening 12 inches high by 12¾ inches wide in a 1½-inch plank, under a constant head of 6 inches above the top of the discharge—showed that 1 miner's inch equaled a discharge of 1.4994 cubic feet per minute. For all practical purposes this may be taken as equivalent to 1.5 cubic feet, or 11¼ gallons of water per minute; in other words, 1 cubic foot per second equals 40 miner's inches. A miner's inch is so interpreted and used in this report.

### SLUICE HEAD

The "sluice head" is a term used by many placer miners to express volume of water that is necessary for separating the gold from the gravel in a sluice box. It is an indefinite and unsatisfactory term, as the rate of flow necessary varies mainly with the size of the sluice boxes, the grade at which they are placed, and the character of the gravel. In Alaska a sluice head is usually considered equivalent to the amount of water necessary to carry properly all the gravel that six to eight men can shovel into a 12-inch sluice box set with a grade of 6 inches in 12 feet. According to differences in conditions, a sluice head ranges from 0.75 to 2.5 second-feet, or 30 to 100 miner's inches. The sluice head as used in New Zealand is equivalent to 1 cubic foot per second, or 40 California miner's inches.

### DETERMINATION OF FLOW IN OPEN CHANNELS

There are three methods of determining the flow of water in open channels—(1) by measurement of slope and cross section and use of formulas, (2) by means of a weir, and (3) by measurements of the

[19] Bowie, A. J., jr., A Practical Treatise on Hydraulic Mining. 1885, p. 126.



velocity of the current and of the area of the cross section. The method chosen depends on local conditions, the degree of accuracy desired, the funds available, and the length of time that the record is to be continued. A simple method of ascertaining the approximate amount of water flowing in an open channel is as follows:

Select along the ditch, flume, or stream, where the water runs smoothly a straight course of nearly uniform cross section. Measure off 110 feet along the channel and set stakes at each end, or stretch a line across, and call the distance 100 feet. Place in the canal as quietly as possible floats made by weighting empty shotgun shells with shot or small gravel and fitting into them cylindrical wooden plugs 4 to 6 inches long. Different kinds of floats may be used, but those so shaped and so weighted as to be least affected by wind are the best. Note the average time in which several floats traverse the distance, divide this distance in feet (100 feet) by the average time in seconds, and the result will be the velocity in feet per second; multiply this by the area of the cross section of the stream in square feet to find the number of cubic feet of water flowing per second. If the cross section of the channel is not uniform, an average should be determined from measurements of the cross section at different places. In surface-float measurements of ordinary streams with rough bottom a deduction of 10 per cent from the surface velocity at the center of the stream is generally made in determining the mean velocity, whereas for canals, ditches, and flumes 5 to 8 per cent may be a fair deduction according to the smoothness of their walls and the form of the cross section.

### ALASKA WATER CONDUITS

The accompanying table on water conduits contains important data on ditches delivering water under various conditions. As there are so many ditches, and reliable detailed data on most of them can not be had, only a few selected examples are given. Many of the ditches can now carry only a small proportion of the water for which they were constructed, and as the quantity usually fluctuates greatly during the season the average stated is only approximate. The cross section also is variable. The data given have been obtained from many sources, mainly from operators. To make and to check such measurements was not practical. Alaska miners seldom note the volume of water used. Although the amount of water supplied by some ditches may seem small, it must be remembered that "ground-sluice" or "bank-head" water may be taken from the immediate creek and not drawn from the ditch. The head or pressure is the difference in elevation between the water level in the penstock and the point where the water is discharged, and as work proceeds upstream the head diminishes accordingly.